State of California
The Resources Agency
Department of Water Resources

PROGRESS REPORT
SP-G1 EFFECTS OF PROJECT OPERATIONS ON GEOMORPHIC PROCESSES UPSTREAM OF OROVILLE DAM

Oroville Facilities Relicensing
FERC Project No. 2100

APRIL 23, 2003

GRAY DAVIS	MARY D. NICHOLS	THOMAS M. HANNIGAN
Governor	Secretary for Resources	Director
State of California	The Resources Agency	Department of Water Resources

State of California
The Resources Agency
Department of Water Resources

PROGRESS REPORT SP-G1 EFFECTS OF PROJECT OPERATIONS ON GEOMORPHIC PROCESSES UPSTREAM OF OROVILLE DAM

Oroville Facilities Relicensing FERC Project No. 2100

This report was prepared under the direction of

Koll Buer .... Senior Engineering Geologist, DWR, Northern District

by

Jonathan Mulder .... Engineering Geologist, DWR, Northern District

Assisted by

Bruce Ross .... Engineering Geologist, DWR, Northern District
Jennifer Weddle....................................... Engineering Geologist, DWR, Northern District
Craig Bourne ....Graduate Student Assistant, DWR, Northern District

REPORT SUMMARY

This document is a Progress Report on activities completed to date in preparation for submission of a final report in December, 2003. The progress report primarily summarizes efforts devoted to completing the following tasks:

Task 2 Map the Channel Resources in the Tributaries Above Oroville Dam
Task 3 Re-Survey Reservoir Cross-Sections and Determine Sediment in Storage

This report is intended only to update the reader regarding methodologies and partial study results completed to date. Final study results and analyses will be presented in the final report.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Current and past operating practices of the Oroville Project may have effects on the geomorphology of Lake Oroville, the main stems of the Feather River above Lake Oroville, and smaller tributaries entering directly into the lake or near its upstream extent. The Environmental Workgroup identified issues related to the geomorphology and operations of the project. Major issues that were identified included Project effects on reservoir sedimentation, mass wasting, shoreline erosion, channel geomorphology, and sediment transport in the Feather River in and above Lake Oroville.

1.1 BACKGROUND INFORMATION

This section is not addressed yet.

1.1.1 Statutory/Regulatory Requirements

This section is not addressed yet.

1.1.2 Study Area

1.1.2.1 Description

The study area includes Lake Oroville and adjacent shoreline, and incoming tributaries up to their first fish passage barrier. The area within the footprint of Lake Oroville was subdivided into two discrete elements based on Project effects, primarily drawdown of the lake level.

1.1.2.1.1 Reservoir Storage Zone Project operations impound varying volumes of water behind Oroville Dam based on tributary inflow, downstream water requirements, and flood prevention. In general, water levels are lower during years of below-average annual precipitation, and higher during years of above-average precipitation. During the 1976-77 drought, the lake level reached its lowest elevation of 645.11 feet above Mean Sea Level (MSL) on September 7, 1977. Lake levels were again dramatically low during the 1990-92 drought when the lake level decreased to 651.48 on January 30, 1991. The Reservoir Storage Zone is defined as that portion of the Lake Oroville footprint that is below the 640 foot elevation. Areas in Reservoir Storage Zone have been inundated ever since the initial filling of Lake Oroville in 1967.

1.1.2.1.2 Fluctuation Zone The area of the reservoir footprint above the 645 foot elevation to the full pool elevation of 900 feet is defined as the Fluctuation Zone. Areas in this zone have been repeatedly inundated and exposed as lake levels rise and fall. Figure 1.1-1 identifies the areal extent of the Reservoir Storage Zone and the Fluctuation Zone. Figure 1.1-2 graphically shows the number of days that the daily lake level has been measured for each one-foot elevation increment above 645 feet.

1.1.2.1.3 Tributaries Study areas in the tributaries include portions of the main Feather River stems upriver to the first fish passage barrier above the lake (see Table 1-1.1). In addition, ten smaller tributaries (2nd order or larger) drain directly into the reservoir footprint (see Table 1.1-2). Stream profiles for the four main tributaries and ten 2nd order tributaries are shown in Figures 1.1-3 through 1.1-7. Refer to Figure 1.1-1 for location of the 2nd order tributaries.

Table 1.1-1. Lake Oroville Main Tributaries.

Name	Fish Barrier Name	Barrier Elevation	Tributary Length (ft)
West Branch Feather River	Miocene Dam	1550’	In progress
North Fork Feather River	Big Bend Dam	900’	N/A
Middle Fork Feather River	Curtain Falls	1200’	30636
South Fork Feather River	Ponderosa Dam	900’	N/A

Table 1.1-2. Lake Oroville Smaller Tributaries.

Name	Plotted Tributary Length (ft)	Location in Reference to Main Tributary
Concow Creek	18838	West Branch
Stony Creek	5733	North Fork
Chino Creek	8438	North Fork
French Creek	14690	North Fork
Berry Creek	In progress	North Fork
Fall River	948	Middle Fork
Frey Creek	9133	Middle Fork
Canyon Creek	40000	Middle Fork
Sucker Run Creek	52401	South Fork
McCabe Creek	5702	South Fork

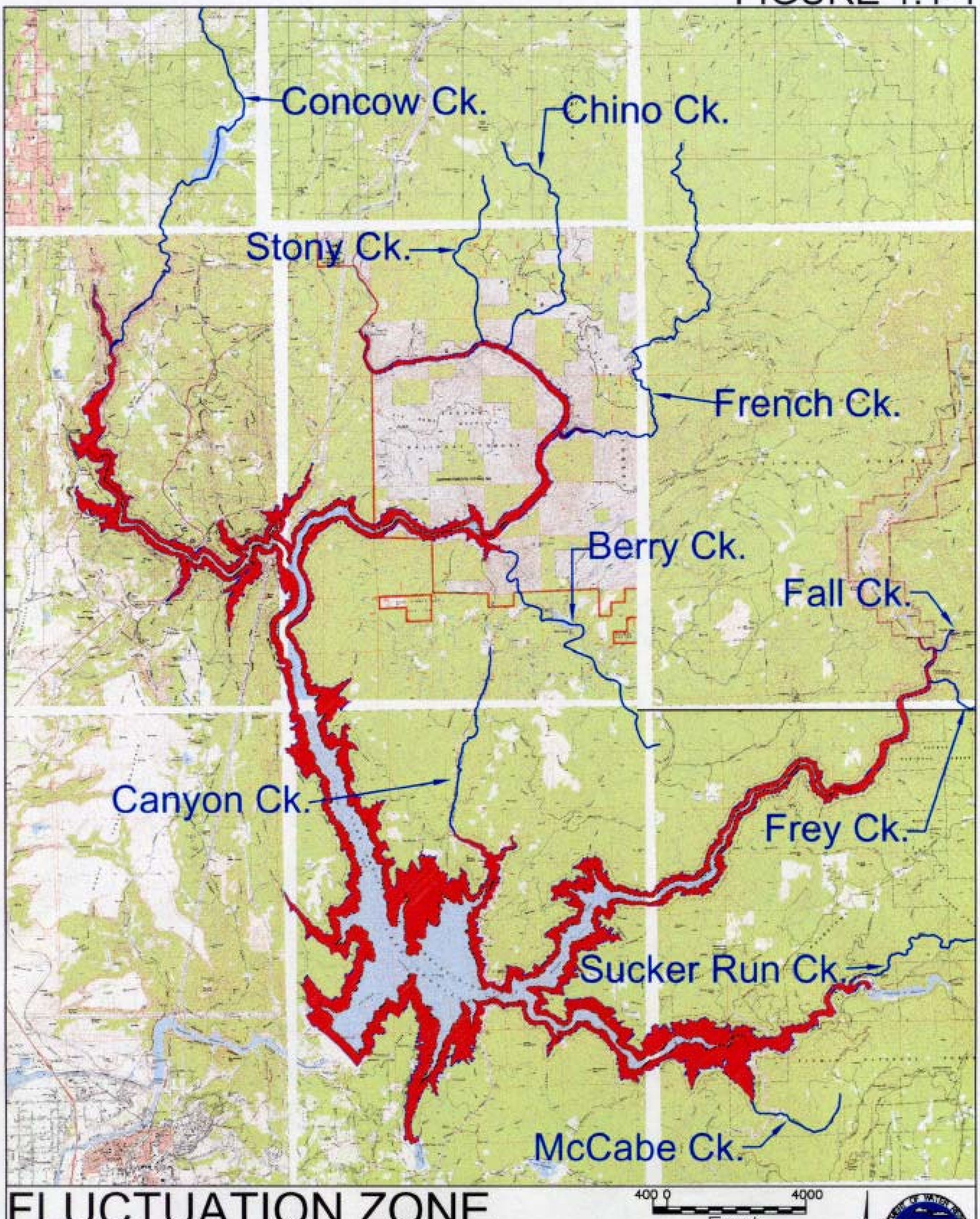
1.1.2.2 History

This section is not addressed yet.

1.2 DESCRIPTION OF FACILITIES

This section is not addressed yet.

FIGURE 1.1-1



FLUCTUATION ZONE

Red-hatched area denotes reservoir footprint between 640' elevation and 900' elevation.

Filename:N:\RAID1\Geo\PROJECTs\FERC_Upstream\FluctuationZone.dwg
Layout Name:Layout1 Plot Time: Apr 21, 2003 - 10:01pm

Oroville FERC Relicensing
(Project No. 2100)

Figure 1.1-2 LAKE LEVEL -- NUMBER OF DAYS PER ELEVATION

DATA FROM FROM OCTOBER 1987 TO PRESENT

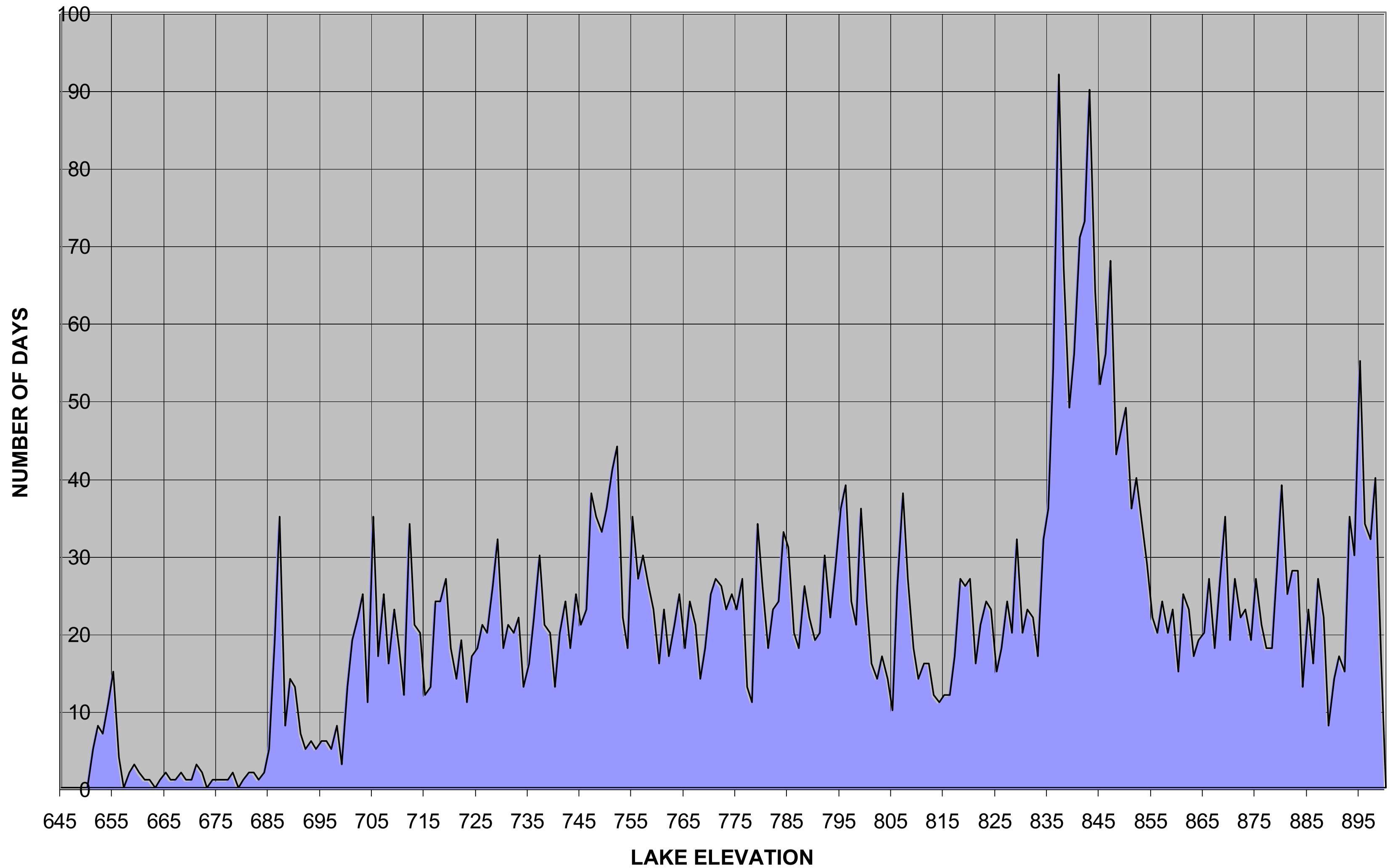
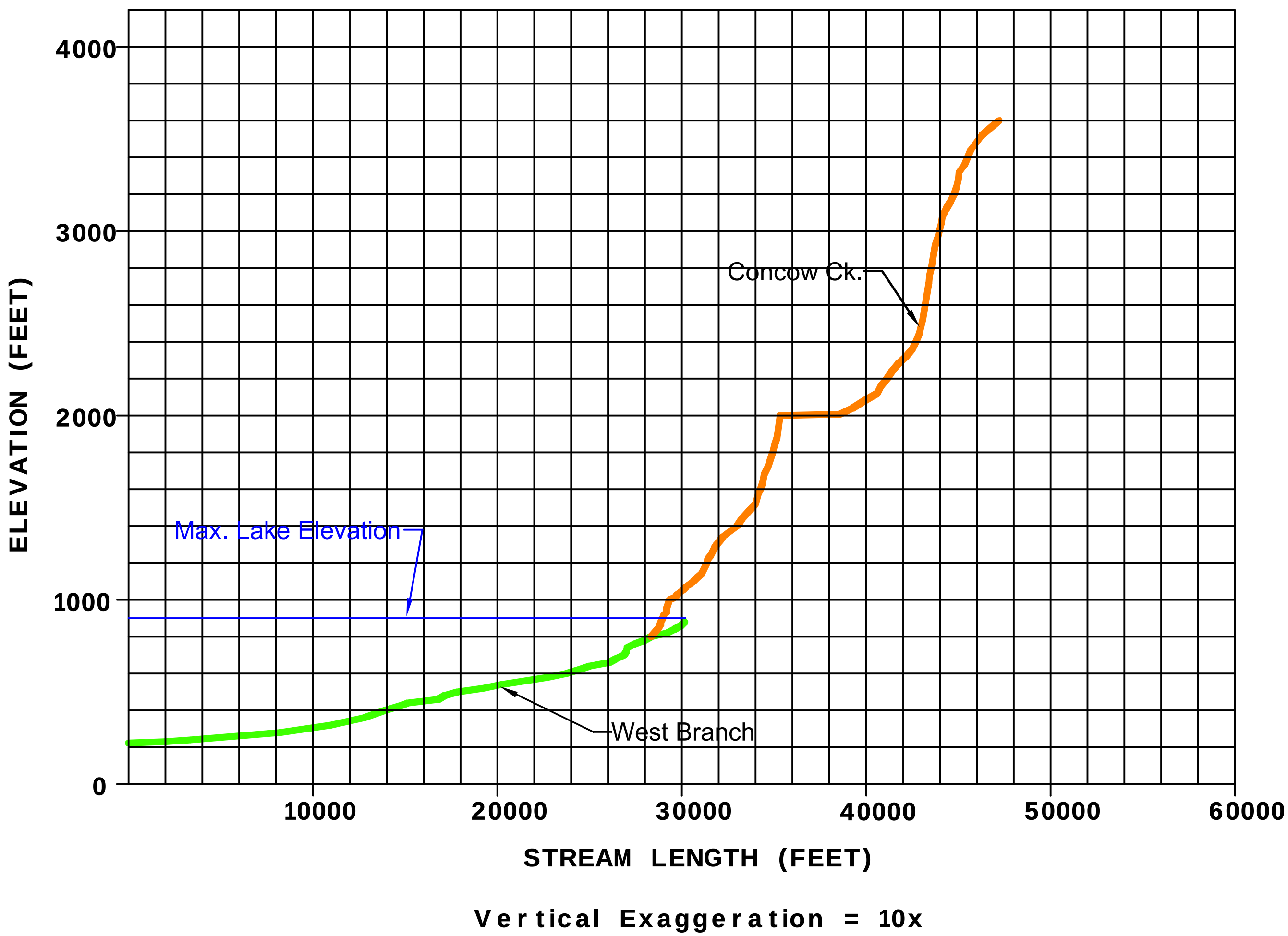


FIGURE 1.1-3

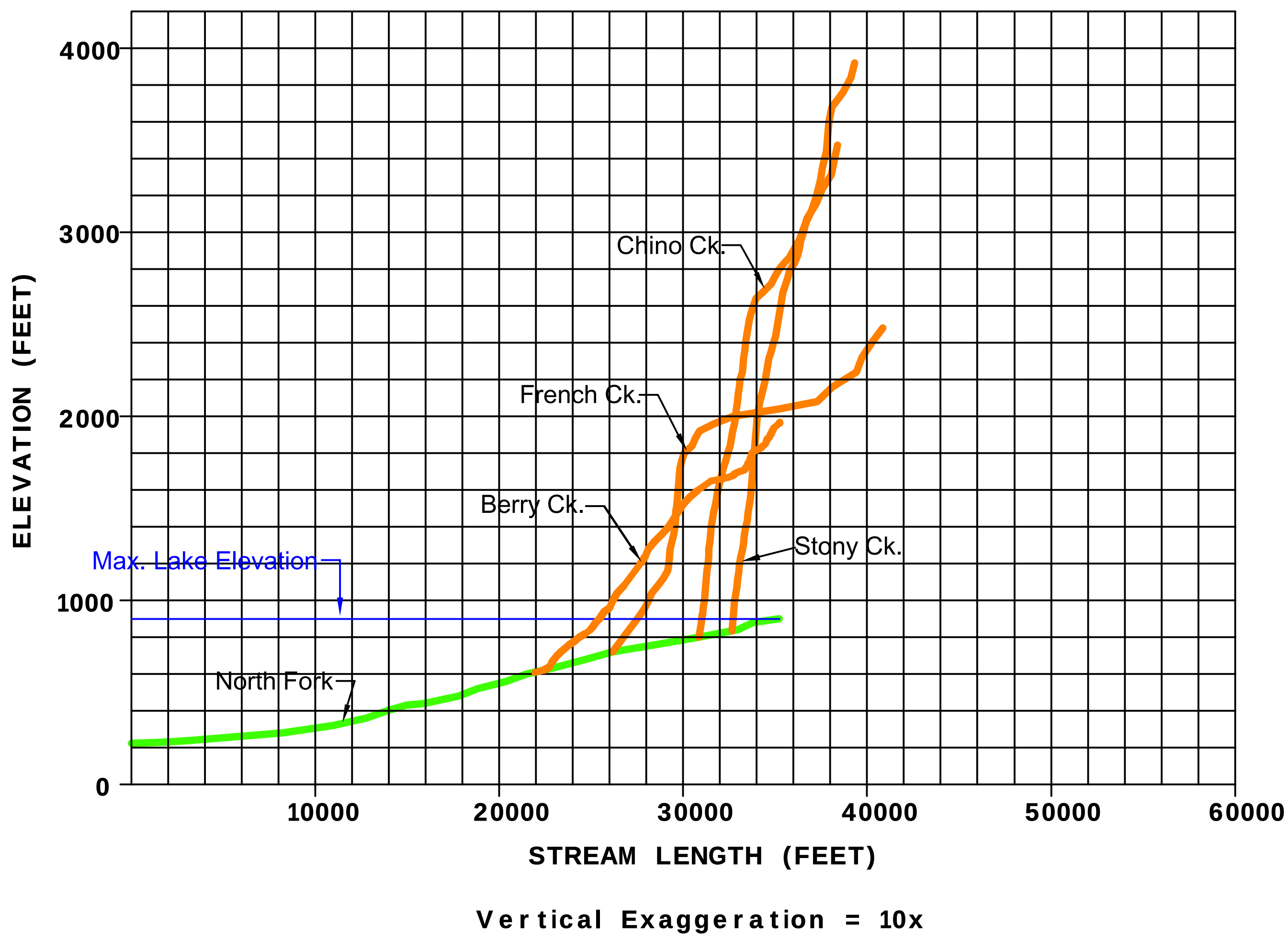


West Branch Feather River Stream Profiles
Including Second Order Streams Entering Reservoir Footprint

Filename:N:\RAID1\Geo\PROJECTs\FERC_Upstream\ThalwegStudy\ThalwegProfiles--04-14-03--lmw.dwg
Layout Name:West Branch   Plot Time: Apr 22, 2003 - 8:37am

Oroville FERC Relicensing
(Project No. 2100)

FIGURE 1.1-4

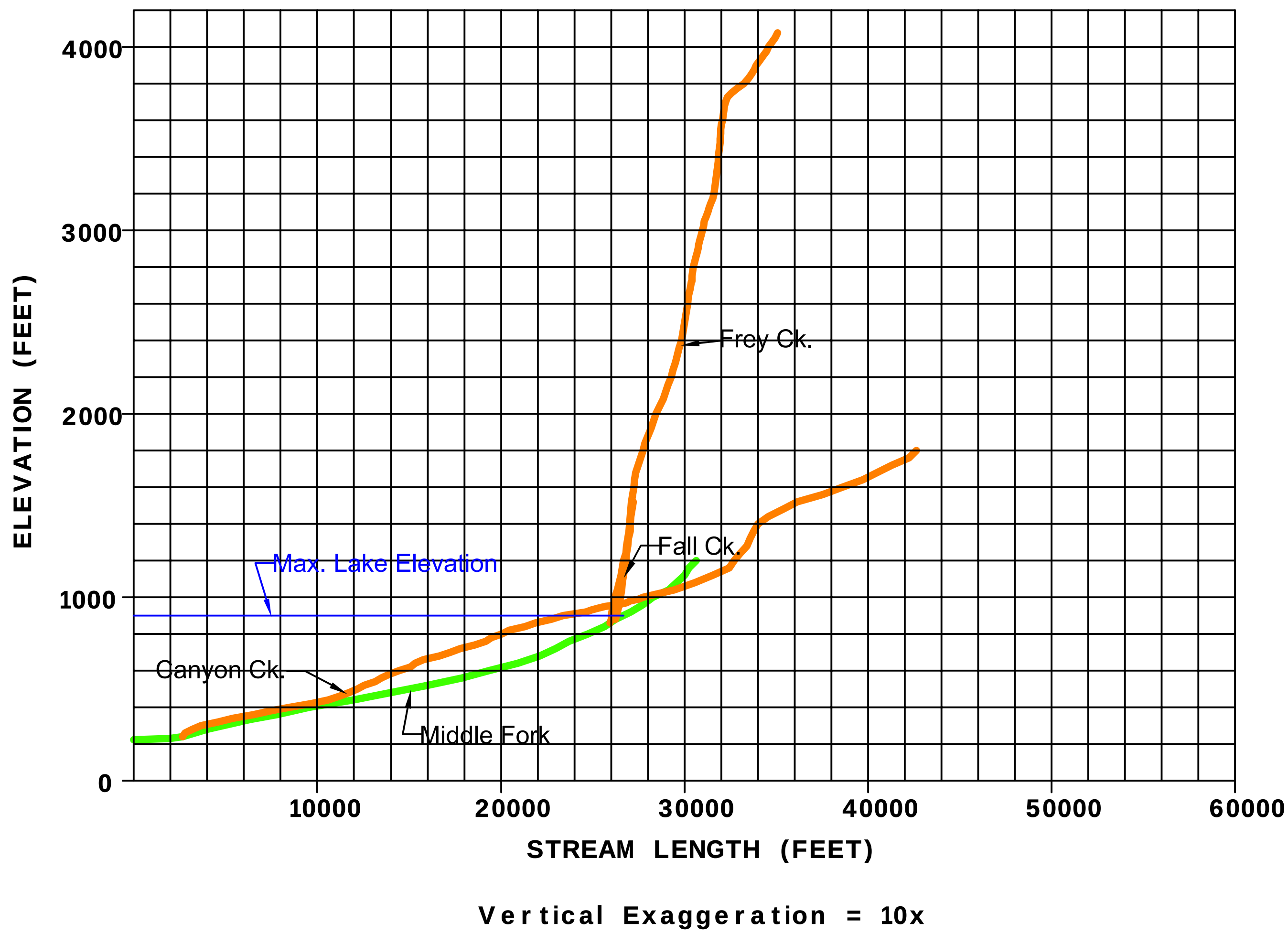


North Fork Feather River Stream Profiles
Including Second Order Streams Entering Reservoir Footprint

Filename:N:\RAID1\Geo\PROJECTs\FERC_Upstream\ThalwegStudy\ThalwegProfiles--04-14-03--lmw.dwg
Layout Name:North Fork   Plot Time: Apr 22, 2003 - 8:38am

Oroville FERC Relicensing
(Project No. 2100)

FIGURE 1.1-5



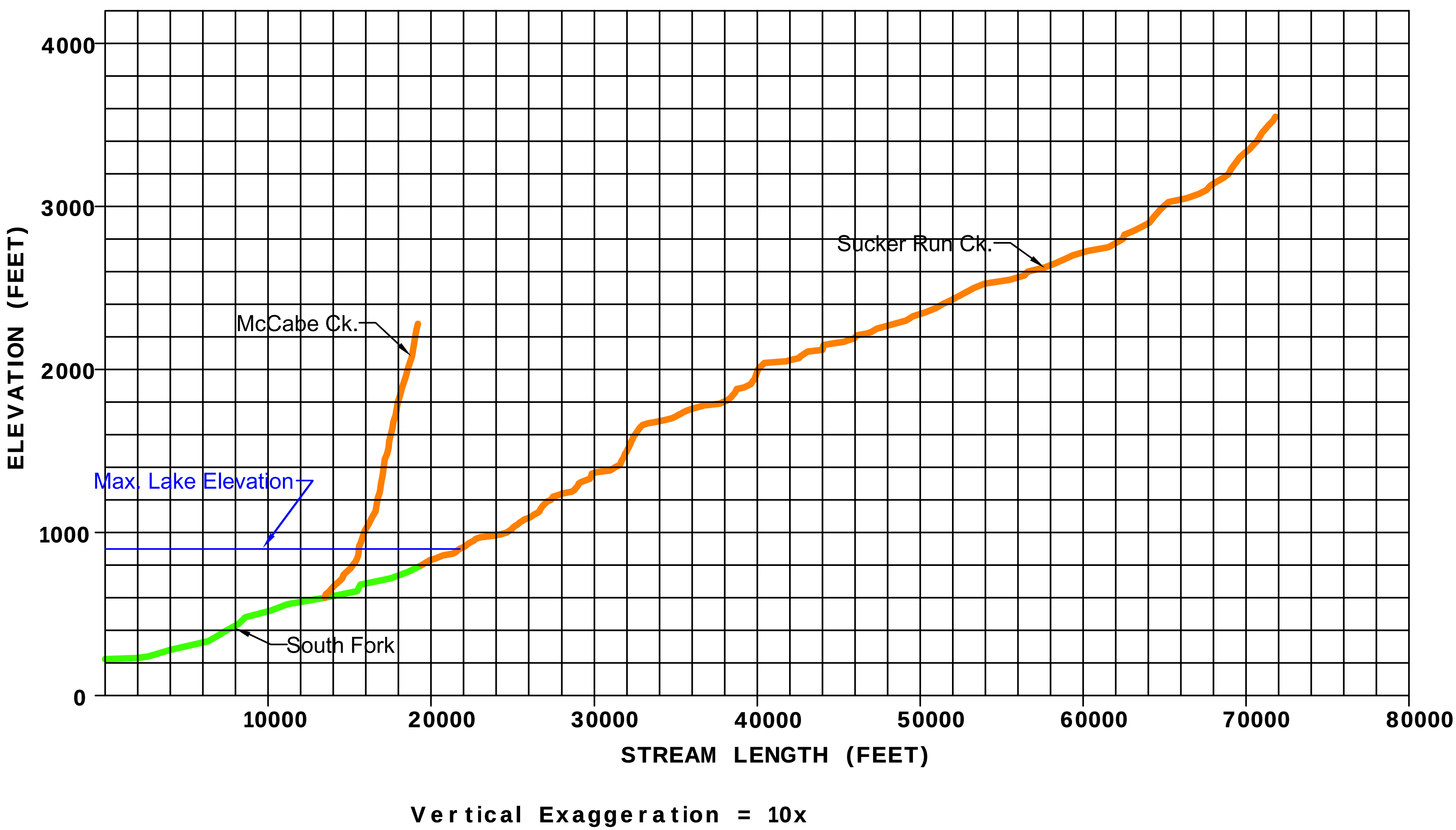
Middle Fork Feather River Stream Profiles

Including Second Order Streams Entering Reservoir Footprint

Filename:N:\RAID1\Geo\PROJECTs\FERC_Upstream\ThalwegStudy\ThalwegProfiles--04-14-03--lmw.dwg
Layout Name:Middle Fork Plot Time: Apr 22, 2003 - 8:37am

Oroville FERC Relicensing
(Project No. 2100)

FIGURE 1.1-6

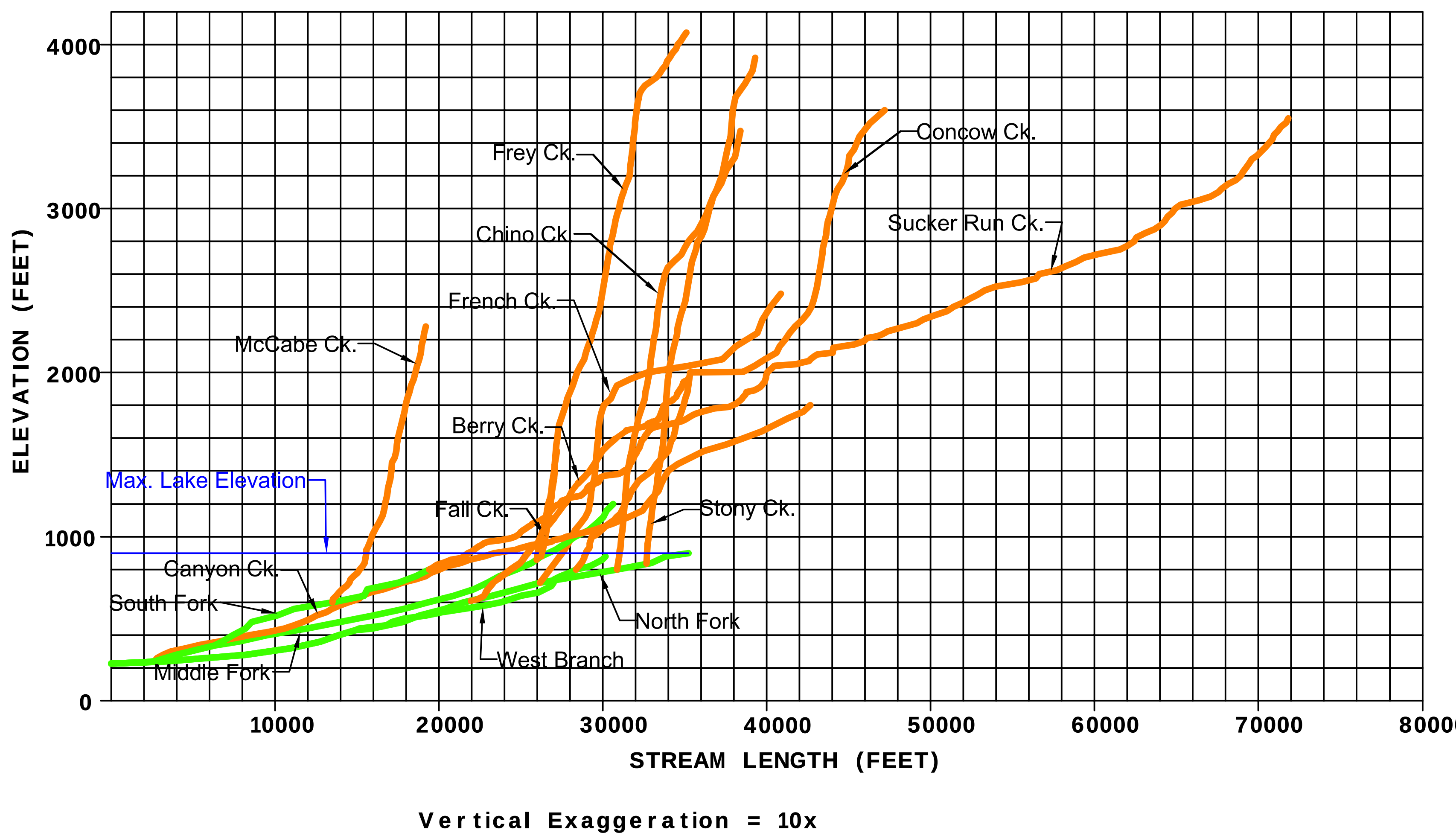


South Fork Feather River Stream Profiles
Including Second Order Streams Entering Reservoir Footprint

Filename:N:\RAID1\Geo\PROJECTs\FERC_Upstream\ThalwegStudy\ThalwegProfiles--04-14-03--lmw.dwg
Layout Name:South Fork   Plot Time: Apr 22, 2003 - 8:34am

Oroville FERC Relicensing
(Project No. 2100)

FIGURE 1.1-7



Feather River Stream Profiles

Including Second Order Streams Entering Reservoir Footprint

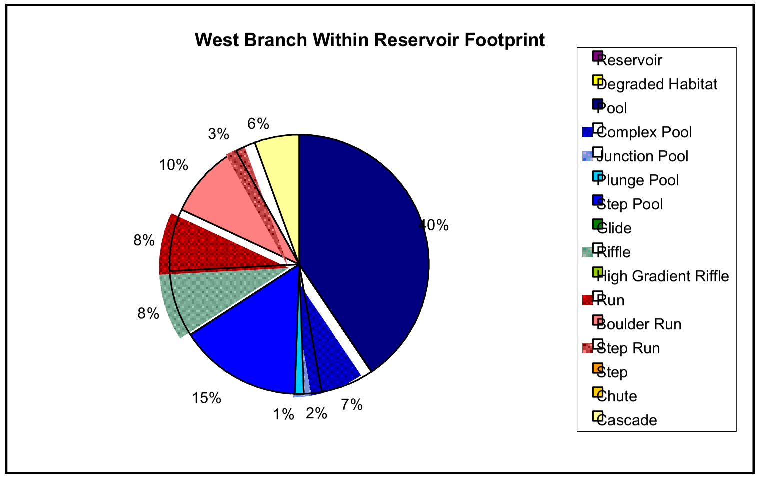
Filename:N:\RAID1\Geo\PROJECTs\FERC_Upstream\ThalwegStudy\ThalwegProfiles--04-14-03--lmw.dwg
Layout Name:Whole River   Plot Time: Apr 22, 2003 - 8:32am

Oroville FERC Relicensing
(Project No. 2100)

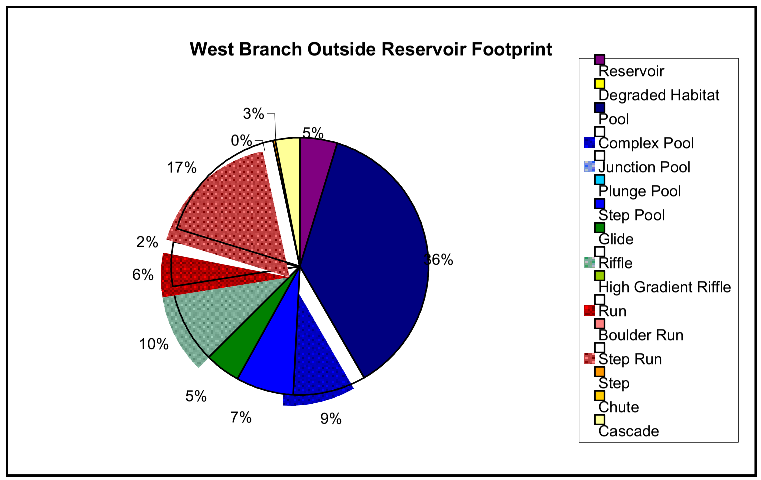
Habitat Type Percentage -- West Branch

TABLE 4.2-5

Habitat Type	Total Length (ft)	Percentage of Each Habitat
Reservoir	0	0%
Degraded Habitat	0	0%
Pool	1849	41%
Complex Pool	300	7%
Junction Pool	100	2%
Plunge Pool	45	1%
Step Pool	700	15%
Glide	0	0%
Riffle	370	8%
High Gradient Riffle	0	0%
Run	365	8%
Boulder Run	445	10%
Step Run	120	3%
Step	0	0%
Chute	0	0%
Cascade	250	6%
Total	**4544**	**100%**



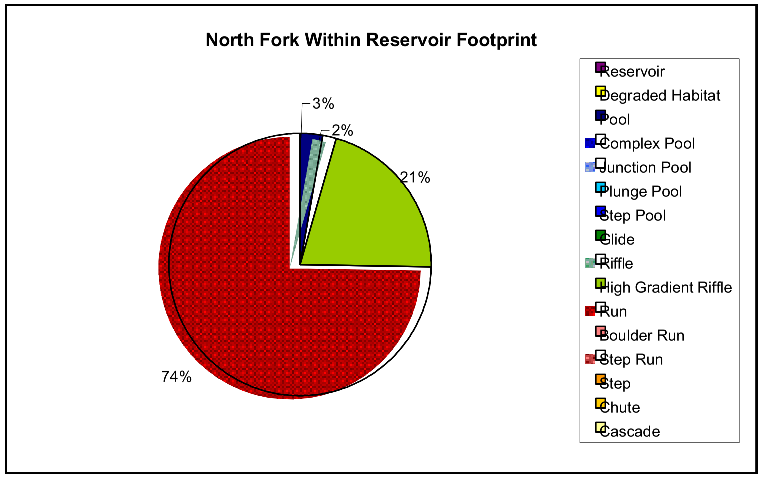
Habitat Type	Total Length (ft)	Percentage of Each Habitat
Reservoir	650	5%
Degraded Habitat	0	0%
Pool	5034	39%
Complex Pool	1250	10%
Junction Pool	0	0%
Plunge Pool	0	0%
Step Pool	980	8%
Glide	630	5%
Riffle	1345	10%
High Gradient Riffle	0	0%
Run	765	6%
Boulder Run	210	2%
Step Run	2327	18%
Step	25	0%
Chute	0	0%
Cascade	425	3%
Total	**12991**	**100%**



Habitat Type Percentage -- North Fork

TABLE 4.2-6

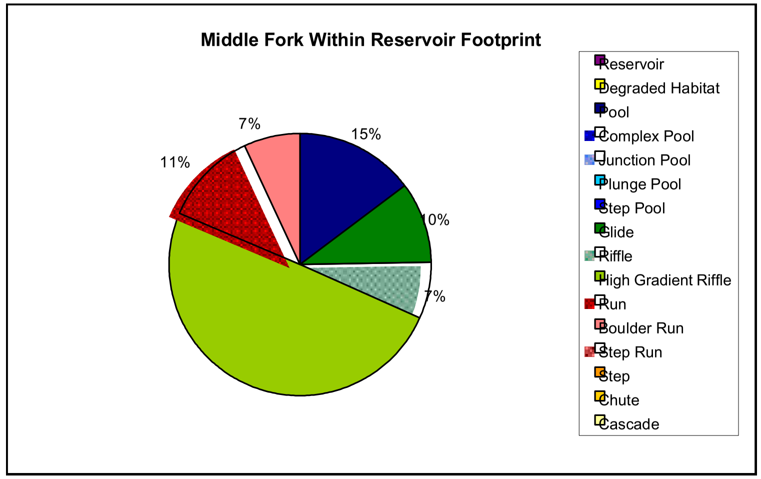
Habitat Type	Total Length (ft)	Percentage of Each Habitat
Reservoir	0	0%
Degraded Habitat	0	0%
Pool	654	3%
Complex Pool	0	0%
Junction Pool	0	0%
Plunge Pool	0	0%
Step Pool	0	0%
Glide	0	0%
Riffle	420	2%
High Gradient Riffle	4956	21%
Run	17898	75%
Boulder Run	0	0%
Step Run	0	0%
Step	0	0%
Chute	0	0%
Cascade	0	0%
Total	**23928**	**100%**



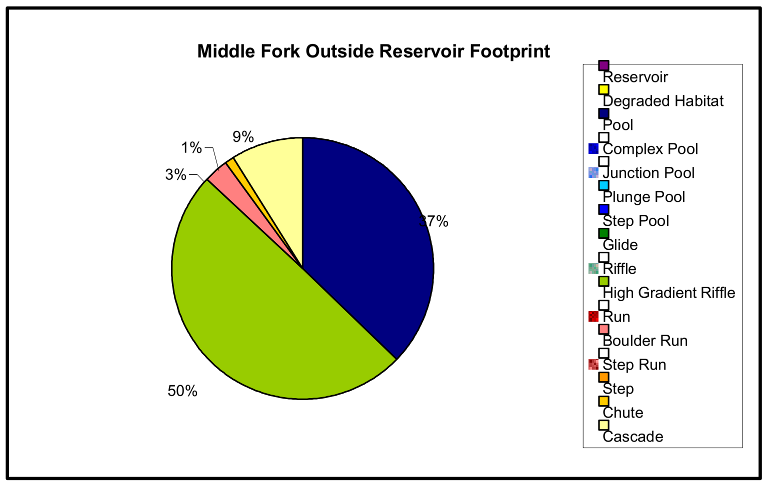
Habitat Type Percentage -- Middle Fork

TABLE 4.2-7

Habitat Type	Total Length (ft)	Percentage of Each Habitat
Reservoir	0	0%
Degraded Habitat	0	0%
Pool	1426	15%
Complex Pool	0	0%
Junction Pool	0	0%
Plunge Pool	0	0%
Step Pool	0	0%
Glide	944	10%
Riffle	674	7%
High Gradient Riffle	4786	50%
Run	1104	11%
Boulder Run	673	7%
Step Run	0	0%
Step	0	0%
Chute	0	0%
Cascade	0	0%
Total	**9607**	**100%**



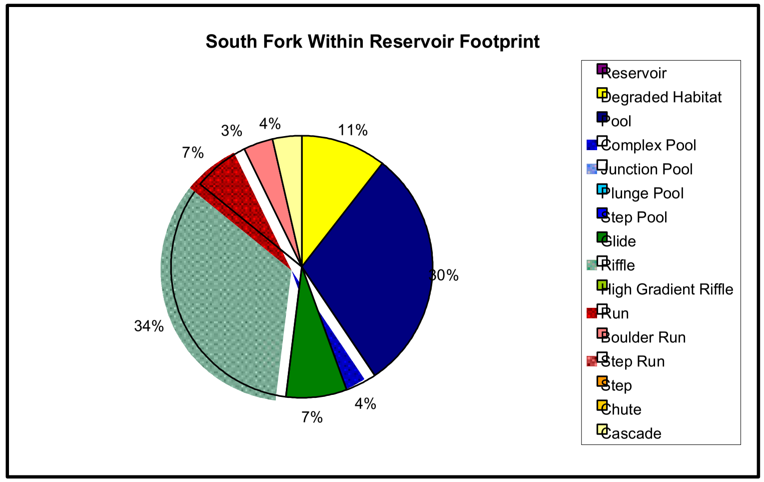
Habitat Type	Total Length (ft)	Percentage of Each Habitat
Reservoir	0	0%
Degraded Habitat	0	0%
Pool	6423	37%
Complex Pool	0	0%
Junction Pool	0	0%
Plunge Pool	0	0%
Step Pool	0	0%
Glide	0	0%
Riffle	0	0%
High Gradient Riffle	8582	50%
Run	0	0%
Boulder Run	505	3%
Step Run	0	0%
Step	0	0%
Chute	206	1%
Cascade	1531	9%
Total	**17247**	**100%**



Habitat Type Percentage -- South Fork

TABLE 4.2-8

Habitat Type	Total Length (ft)	Percentage of Each Habitat
Reservoir	0	0%
Degraded Habitat	900	11%
Pool	2554	30%
Complex Pool	345	4%
Junction Pool	0	0%
Plunge Pool	0	0%
Step Pool	0	0%
Glide	626	7%
Riffle	2903	34%
High Gradient Riffle	0	0%
Run	600	7%
Boulder Run	292	3%
Step Run	0	0%
Step	0	0%
Chute	0	0%
Cascade	317	4%
Total	**8537**	**100%**



2.0 NEED FOR STUDY

Relicensing participants have identified the altered sediment routing and reservoir drawdown caused by the Oroville Facilities as potential project effects on the river above the lake. The geomorphic investigation will compare historical and current conditions to help quantify ongoing project affects. This information will help address continuing effects to native plant and animal habitats and riparian resources from hydrologic, channel, and sediment routing changes. These data, together with other study results, will provide boundary conditions for identifying and assessing potential management actions.

3.0 STUDY OBJECTIVE(S)

This section is not addressed yet.

4.0 METHODOLOGY

4.1 STUDY DESIGN

The SP-G1 Workplan identified seven individual tasks:

1) Obtain and Review Existing Resource Data
2) Map the Channel Resources in the Tributaries above Oroville Dam
3) Re-Survey Reservoir Cross-Sections and Determine Sediment in Storage
4) Cross-Section Monitoring
5) Determine Changes in River Geomorphic and Hydraulic Parameters
6) Prepare Draft Report
7) Prepare Final Report

Task 1 activities began in March 2002 and are ongoing. Task 2, 3, 4, and 5 activities involve field work in the study area, began in March 2003, and are ongoing. Task 6 activities have begun and will be completed by December 2003. Task 7 will be completed in early 1994 after review of the draft report.

4.2 HOW AND WHERE THE STUDIES WERE CONDUCTED

4.2.1 Task 1—Obtain and Review Existing Resource Data

4.2.1.1 Previous Cross Section Studies DWR initiated a study of reservoir cross sections in 1971. Twenty-four cross section locations were selected and monumented. The cross section profiles were measured using a current state-of-the-art Raytheon fathometer. Seventeen of the cross sections were re-surveyed in 1994 to determine sedimentation rates.

4.2.1.2 Map Base Standard 7½" topographic maps were utilized for the study base map. Archival research at DWR's Photogrammetry Section revealed that detailed mapping of the Lake Oroville footprint area and adjacent side slopes had been developed based on aerial photography flown in the early 1960's. Generally, these maps were drawn on a plastic mylar base at a scale of 1:4800 (i.e. 1 inch = 400 feet) and a contour interval of 20 feet. Northern District staff scanned the mylar maps into computer graphic TIF (Tagged Image Format) files. Staff then geo-referenced the TIF files so that they could be properly inserted into the base map file and incorporated into the FERC study GIS project.

4.2.1.3 Geologic Map Base DWR published a geologic map of the Lake Oroville area as part of the August 1, 1975 Oroville Earthquake Investigations (Bulletin 78-203). Northern District staff digitized and geo-referenced the geologic map for incorporation into the FERC study GIS project. A reduced version of the geologic map is shown in Figure 4.2-1. Full-size (34" x 44") versions of the map are available upon request to the GIS unit.

4.2.2 Task 2—Map the Channel Resources in the Tributaries above Oroville Dam

Channel resources above Oroville Dam are being mapped within the reservoir footprint in the Fluctuation Zone and along major tributaries above the 900 foot level to the first fish barrier in Fall 2002. Mapping currently consists of delineating river reaches using the habitat characterization scheme as developed by the Surface Water Resources, Inc. (SWRI) for study plan SP-F3.1 (see Table 4.2-3). Some habitat types were further differentiated based on California Department of Fish and Game California Salmonid Stream Habitat Restoration Manual, Part III, Habitat Inventory Methods (See Appendix A) River reach widths, average depths, substrate quality, spawning gravel quality, and cover type were noted. Length and width measurements were obtained using a laser range-finder. Depth measurements were made with a stadia rod. Cover type was based on the codes developed by DWR and are based on the criteria shown in Table 4.2-4.

Table 4.2-3 Habitat Definitions

Habitat Unit	Defining Characteristics
Riffle	Typically shallow reaches with swifty flowing, turbulent water; sometimes have partially exposed substrate, typically composed of cobble; small, breaking surface waves are a good indicator
Run	Swift flowing reaches with little surface agitation and no major flow obstructions; may appear as flooded riffles; similar to glides but shallower and with less uniform bottom surface; typical substrate consists of gravel, cobble, and boulders
Pool	Relatively deep with fine-grained substrates; relatively low gradient with relatively low water velocities; tranquil; section controlled
Glide	Uniform channel bottoms with moderate to low flow velocities and little turbulence; substrate is variable; swift flowing but less turbulent and deeper than riffles; deeper and more uniform bottom than runs
Backwater	Pool formed outside or at the margins of the main channel; exhibit little to no flow velocity; often elongate with long axis parallel to the main river channel, but lacking flow input to the upstream end of the backwater; water inside the backwater pools is effectively dammed by adjacent main channel water; usually deepest at the point closest to main channel flow; substrate usually consists of fines
Cascade	Very steep riffle habitats, consisting of alternating small waterfalls and shallow pools, generally with bedrock or boulder substrate

Table 4.2-4 Cover Code Descriptions

Cover Code	Description
A	No apparent cover
B	Small to medium instream objects/woody debris (<31 cm or 1 ft. in diameter)
C	Large instream objects/woody debris (>31cm or 1 ft. in diameter)
D	Overhead Objects
E	Submerged aquatic vegetation
F	Undercut bank

Mesohabitat maps (Appendix A) were prepared for the four main stems both upstream of the reservoir and within the reservoir footprint. Mesohabitat mapping upstream of the reservoir was performed only on the West Branch and Middle Fork. Mapping on the West Branch included a portion of channel above the Miocene Dam fish barrier because of easier accessibility and comparison with habitat below Miocene Dam. Fish passage barriers on the North Fork and South Fork (Big Bend Dam and Ponderosa Dam, respectively) precluded mesohabitat mapping upstream of the barriers.

The areas that were inaccessible were mapped in stereo from color aerial photography or from black-and-white digitally orthorectified quarter quads (DOQQs). DOQQs were used only outside of the color aerial photo coverage. The North Fork was mapped using color stereographic images from aerial photography flown in September 1990, while portions of the Middle Fork were mapped in the field, from aerial photography flown in April 1996, and from DOQQs. The West Branch and South Fork were mapped based on field observations.

All four major tributaries exhibit a significant sediment wedge which extends from the lake level upstream one to three miles at a very low gradient. The low gradient and abundant sediment load contribute to a braided stream pattern. As the lake level lowers, incoming flows continually erode the wedge lower into the reservoir footprint. The Middle Fork and North Fork (Figures 4.2-2 and 4.2-3) have sufficient discharge flows so that the leading edges of the wedges are nearly level with the lake elevation. The West Branch and South Fork, on the other hand, (Figures 4.2-4 and 4.2-5) have lesser discharge flows so that the leading edges of the wedges are not always at the level of the lake. A detailed discussion of the geomorphic characteristics of the sediment wedges will be presented in the final report.

The dynamic nature of the stream on the sediment wedge, particularly the constant erosion and redeposition of the bed load, precluded mesohabitat mapping on the sediment wedge. However, mesohabitat mapping within the reservoir footprint was conducted along the main stems above the upper ends of the sediment wedges.

4.2.2.1 West Branch of the North Fork

Mesohabitat along the West Branch has been mapped in three sections: 1) from the bridge on Jordan Hill Rd. to approximately two miles below Miocene dam;, 2) from 49er Gulch down approximately ¾ of a mile; and 3) from Concow Creek downstream to the start of the sediment wedge (See Appendix A, Sheets WB-1 through WB-6) Total mapped channel length was approximately 15,900 feet.

The reservoir behind Miocene Dam is almost completely full of sediment (Figure 4.2-6). The dam no longer functions as a significant sediment trap; clastics up to medium cobble-size appear to pass over the dam. A deep plunge pool occurs immediately downstream of Miocene Dam. Depths in the pool range from 5 to over 20 feet. The height of the dam above the pool is approximately 12 feet (Figure 4.2-7). Miocene Dam is maintained by P.G. & E. and diverts approximately 25 to 35 cfs into Miocene Ditch. In-stream gages on the West Branch near Miocene Dam are non-existent; however, during the day that Northern District staff hiked this portion, it appeared that over half of the total volume of flow was diverted in to the Miocene Ditch.

A wide range of habitat types occur along the West Branch above the reservoir footprint with pool types predominating at 53%, run types at 25%, riffles/glides at 15% and cascades at 3% (see Table 4.2-5). The remaining 5% comprised the reach occupied by Miocene Reservoir. Figure 4.2-8 shows the typical habitat downstream from the Jordan Hill Road crossing. A 500-foot long pool flows into 250 feet of step run, then 100 feet of riffles, then another 185-foot long pool. Figure 4.2-9 shows a pool merging into a step run (Reaches 61 & 62) downstream from Miocene Dam. Flow through this reach was estimated at about 15cfs. Spawning gravel quality was assessed as "good to excellent".

The sediment wedge on the West Branch stretches from Cape Horn approximately ¼ mile downstream (see Figure 4.2-10). The sediment wedge is composed primarily of medium to coarse sand with minor small pebbles and some cobbles. Fine silt covers the elevated portions of the wedge that have not been reworked by the river current as the lake elevation lowered (see Figure 4.2-11).

Mesohabitat typing within the reservoir began at the upper terminus of the sediment wedge where the river channel narrows near Cape Horn. The lower portion is predominated by runs and riffles in the narrow gorge upstream of Cape Horn. Pools interspersed with runs and/or riffles become more common as the river channel widens and gradient becomes less steep. A very notable feature is a deeply incised inner gorge about ¼ mile south of Concow Creek and continuing downstream about ¼ mile (see Figures 4.2-12 and 4.2-13) containing two long pools separated by 140-foot long cobble riffle sequence. The downstream pool (Reach 75) has an average depth of about 20 feet. The substrates in both pools are bedrock or boulders covered by silt.

4.2.2.2 North Fork

In late August 2002, Northern District staff accessed the upper portion of North Fork arm of Lake Oroville by proceeding downstream from the P.G. & E. Powerhouse. The abandoned Western Pacific railroad grade parallels the North Fork and provides fairly easy access along the reservoir from Big Bend Dam downstream to Chino Creek where the grade is washed out. A 4-wheel dirt road continues on the other side of the wash-out following the railroad grade until approximately ¾ mile upstream of French Creek. The elevation of the railroad grade at Big Bend Dam is about 1040 feet; elevation at Chino Creek is about 940 feet. Access from the railroad grade down to the river channel is severely limited due to the steepness and instability of the slopes. Staff were able to descend down to near the water's edge in two locations, however were not able to traverse much distance either upstream or downstream.

Flow in the North Fork is determined by the operating requirements of Poe Powerhouse and fluctuate widely over a short time frame. Figures 4.2-14 and 4.2-15 show the amount of flow variation over the Big Bend Dam in about four hours. During high flows, water occupies the entire river channel along most reaches (see Figures 4.2-16 and 4.2-17). The fluctuating flows and difficult bank access precluded traversing along the stream channel.

In early November 2002, Northern District staff attempted to access the upper portion of the North Fork arm from the downstream side. Lake elevation at that time was 700 feet. Flowing current was encountered just downstream from Berry Creek, (see Figures 4.2-18 and 4.2-19) indicating the lower extent of the major sediment wedge. It was hoped to traverse along the abandoned railroad grade up the North Fork and begin stream typing at the upper end of the sediment wedge. However, staff was not able to access the railroad grade upstream of Berry Creek.

As a result of access difficulties, staff prepared an interim mesohabitat map based on aerial photography flown in April 1996 (see Appendix B, Sheets NF-1 through NF-5). Flow volume at the time of the photos is unknown, but, as stated before, flow varies greatly in the North Fork. Habitat mapping was completed for the river reaches starting at Big Bend Dam downstream about 4 ½ miles, where the reservoir began in the aerial photos. The habitat type was predominated by runs (74%) and high gradient riffles and riffles (23%) (see Table 4.2-6). Only 3% of the typed reach was classified as pool. The high variability in flows makes the habitat typing difficult. For example, Figures 4.2-20 and 4.2-21 show reaches that were typed as runs or high gradient riffles based on the 1996 aerial photography, but may actually be a series of pools, riffles, and runs at a lower flow.

The presence of a very large sediment wedge on the North Fork indicates that significant quantities of sediment are not being retained upstream. Big Bend Dam is nearly full of sediment (Figures 4.2-22 and 4.2-23); bed load sediment is most likely passing over the dam during high winter storm flows.

4.2.2.3 Middle Fork

Northern District staff accessed a portion of the Middle Fork arm upstream of the sediment wedge but still within the reservoir footprint on October 22, 2002. Reservoir elevation at that date was 709 feet. A sediment wedge was encountered about ¼ mile upstream of the MF-6 Cross Section location (see Appendix B, Sheet MF-4).

The sediment wedge filled the entire river channel at the point where it entered Lake Oroville (see Figures 4.2-24 and 4.2-25) and was at or near the current lake level. Flows in the Middle Fork were sufficient to continually work over the entire width of the wedge and erode it down to the current lake level. This phenomenon is similar to the continual reworking of the North Fork sediment wedge where flows are also sufficient to erode the entire width of the wedge.

Figure 4.2-26 shows a portion of the wedge about halfway up its length with wedge deposits three to five feet above the level of the river. The upper foot of the wedge is fine grained (i.e. fine sand to silt) and contains layers of organic material (see Figure 4.2-27).

The sediment wedge continued approximately 6500 feet upriver (see Figure 4.2-28) to a point where the channel narrows and gravel, cobbles, and bedrock comprise the bulk of the stream substrate. Mesohabitat typing began at this point and continued upriver about 3600 feet. Access difficulties (see Figure 4.2-29) and time constraints prevented further typing upstream.

The field-typed stretch is composed of about 20% pools, 45% glides or riffles, and 35% runs (See Table 4.2-7). Substrate fine to coarse gravel with some cobbles and boulders. Abundant cobble to sand sediments line the actual river channel (see Figures 4.2-30 and 4.2-31); these deposits are most likely remnants from when the sediment wedge currently further downstream resided higher up in the reservoir footprint. The side channel material provides abundant substrate material for the Middle Fork. Spawning gravel quality along the entire typed stretch was rated “good to excellent”.

Additional typing upstream was accomplished by examining aerial photos from April, 1996 (Reaches 149 through 168) and from DOQQs (Reaches 169 to 194) further upstream to Curtain Falls. Reaches 149 through 159 are within the reservoir footprint while Reach 160 through 194 are above the footprint.

The typed reaches were about 31% pools, 61% high gradient riffles/boulder runs, and 8% chutes/cascades. Widths, average depths, substrate types, gravel quality, and cover code were not interpreted from the aerial photos or DOQQs. Staff intend to access this area in Spring 2003 when reservoir levels are at or near their highest.

4.2.2.4 South Fork

Mesohabitat along the South Fork has been mapped within the reservoir footprint from Ponderosa Dam downstream about 8500 feet on October 16, 2002 (see Appendix B, Map Sheets SF1- SF2). Flows fluctuate widely out of Ponderosa Dam based on operating criteria for the P.G. & E. powerhouse feeding into Ponderosa Lake. Figure 4.2-32 shows Ponderosa Dam spilling water into the Middle Fork in the late afternoon of October 16th; flow is very roughly estimated at 50 cfs. However, flow earlier on the same day was barely 5 cfs. Figure 4.2-33 shows a large boulder on the left side of Reach 93 (looking downstream). This is the same large boulder on the left side of Reach 93 (looking upstream) the typed reach. Because of the varying flows and an obvious high water stain, it was decided to type the stream reaches based on a higher flow condition than the 5cfs that was currently in the river.

The typed reaches were about 34% pools, 41% glides/riffles, 10% riffles, and 4% cascades (See Table 4.2-8). In addition, an 11% portion on the downstream end was classified as degraded habitat because it was considered to be part of the main sediment wedge on the South Fork. Figure 4.2-34 shows a typical pool (Reach 103) 4 feet deep and 30 feet wide. Substrate in this reach varied from sand to boulders with bedrock along the left bank. Sucker Run Creek joins the South Fork at Reach 106 and was flowing at about 5 cfs at the time of typing. Gravel quantities appear nearly depleted on the South Fork above Sucker Run Creek, but increase downstream due to the gravel contribution from Sucker Run Creek. Figure 4.2-35 shows Reach 107 downstream from Sucker Run Creek; substrate was sand to cobble. Spawning gravel quality was rated as “poor” above the confluence of Sucker Run Creek and South Fork, and “good to excellent” below the confluence.

Many of the pools are bedrock controlled with a steep run or cascade at their downstream ends. Figure 4.2-36 shows a pool (Reach 120) with a sand and gravel substrate flowing into a bedrock controlled cascade. Lower portions of the typed reach have substrates with increasing proportions of fine to coarse sand. The increase in sand content is probably due to the erosion of a remnant sediment wedge lining the sides of the channel as seen in Figure 4.2-37.

4.2.3 Task 3— Re-Survey Reservoir Cross-Sections and Determine Sediment in Storage

4.2.3.1 Previous Work

DWR staff from Central District conducted an initial siltation study in 1971, four years after the initial filling of the reservoir. Twenty-four cross section locations were previously selected and established in 1968. Monuments at the endpoints generally consisted of 1 ½” galvanized pipe set firmly in the ground. Brass end-caps were placed on top of the pipes and the cross section endpoint identification was stamped in the end-cap. In addition, a 8” x 20” highway reflector plate was clamped to the galvanized pipe and the endpoint identification was stenciled on the reflector plate. In some cases, a modified brass end-cap was cemented directly onto the rock outcrop and the reflector plate was attached to a nearby tree. All 24 of the cross sections were sounded utilizing a U.S. Geological Survey Raytheon Fathometer with a range of 250 fathoms. The study concluded that very little siltation had occurred since the initial filling of the reservoir with the exception of MF-8, where approximately 20 feet of sediment was detected. The study included the recommendation that subsequent siltation studies be conducted every ten years or longer and that the study focus on the two most-upstream sections on the North Fork and Middle Fork (i.e. NF-8, NF-9, MF-7, and MF-8).

DWR Northern District resurveyed 17 of the 24 cross sections. Four of the most-upstream sections in both the North Fork and the Middle Fork (i.e. NF-6, NF-7, NF-8, NF-9, MF-5, MF-6, MF-7, MF-8) were surveyed in 1993 and the remaining nine cross sections (NF-2, NF-3, NF-4, NF-5, MF-1, MF-2, MF-3, MF-4, and WB-1) were surveyed in 1994. Cross sections in the South Fork and upper West Branch were not surveyed in this study. Several of the original endpoint monuments were missing and were re-set utilizing measurements from the back-site monuments. The cross sections were sounded using an electronic depthfinder and a transducer with a narrow 4-degree cone. Side slope profiles above the lake surface were surveyed with a theodolite and electronic distance meter (EDM). The study concluded that the two most-upstream sections in the North Fork and Middle Forks experienced erosion of their bed material. Intermediate sections in the North Fork (i.e. MF-7 and MF-6) and in the Middle Fork (MF-6 and MF-5) received substantial increases in sedimentation. The report also concluded that sedimentation in the most-downstream sections was the result of reservoir bank erosion; the report estimated about one foot of bank erosion between the elevations of 900 and 650 feet. The study included the recommendations that all monuments be set in concrete and assigned absolute coordinates in the Global Positioning System (GPS), and that some monuments be reset above areas affected by wave action. In addition, the study recommended that the sections be resurveyed after major storm events, on a periodic basis, or after changes in upstream reservoir operations, and that the amount of reservoir bank erosion be measured and monitored.

4.2.3.2 Current Study

4.2.3.2.1 Existing Cross-Sections

Northern District staff began a program of re-surveying all twenty-five cross-sections in June 2002. Endpoint monuments for most of the sections were re-located and assigned real-world coordinates (California State Plane Coordinates, NAD 83, Zone 2) using Trimble GPS equipment. A few endpoint monuments were not located; their positions were determined from monumented backsites and previous survey records.

GPS equipment was used for this project and was found to be highly successful. For most of the GPS surveying, a transmitting base station was set up over a known vertical bench mark, near the Foreman Creek Boat Launch. The mountainous terrain and winding river channels however, reception of the base station signal at locations further up the tributaries. As a result, three additional base stations were surveyed in and used at 1) Lime Saddle Marina; 2) Berry Hill; and 3) Feather Falls townsite. Nonetheless, repeater transmitters had to be set up along the lake shore for the uppermost cross-section locations in the North Fork and the Middle Fork.

Twenty-one of the original 25 cross-sections were surveyed and sounded. The location of the endpoints for the uppermost section in the Middle Fork (MF-8) could not be relocated and was not surveyed or sounded. In addition, low water and difficult access prevented completion of the study at four sections (WB-2, WB-3, WB-4, and WB-5) in the West Branch. Staff intends to complete the study at the remaining five cross-sections in Spring 2003.

4.2.3.2.2 Thalweg Investigation

Previous sedimentation studies in Lake Oroville focused exclusively on data derived from the 25 cross sections. Current GPS technology enabled staff to locate and maintain a course directly above the thalwegs of the tributaries. As a result, staff was able to sound a long stretch of the thalweg profile and compare the sounding results against elevation information from maps produced prior to construction of Lake Oroville. Thalweg profiles were generated for 3500 feet along the North Fork and 2500 feet along the Middle Fork. The locations of these two profiles were based on a “best guess” as to where the major sediment wedges were located in each of the tributaries.

The thalweg profile for the North Fork revealed a nearly level lake bottom for over 2500 feet with a lake bottom elevation of around 720 feet. The downstream section of the profile steepened then plunged down to a depth of about 690 feet, indicating the leading edge of a sediment wedge.

The thalweg profile for the Middle Fork revealed a fairly flat lake bottom at about the 720 to 725 foot elevation, then an abrupt drop-off to about the 675 foot elevation. The lake bottom continued dropping slightly along 7000 feet of thalweg section, then plunged down to a depth of 625 feet. The remaining 1200 feet of thalweg section dropped at a gradient nearly consistent with the original thalweg profile from before construction of the reservoir.

Staff revisited the locations of the two thalweg profile soundings in late Fall, 2002, when the lake level was below 700 feet. Thalweg sections that had previously been sounded at about 720 feet had been eroded down to at or near the current lake elevation. In addition, the leading edges of the thalwegs had migrated several hundred feet downstream, indicating a mass transfer of sediment from the top of the wedge to the lower leading edge of the edge.

Conclusions and results of the cross-section and thalweg study have not been entirely developed yet. Staff intends to complete the study at the remaining five cross-sections in Spring 2003. In addition, staff intends to sound the thalweg profiles of the four main tributaries along most of their in-lake extent.

<u>4.2.3.2.3 Slope Stability Investigation</u>

Northern District staff has prepared a Slope Stability map of the Lake Oroville area (see Figure 4.2-38). Field checking of mapped features is currently in progress.

Figure 4.2-1

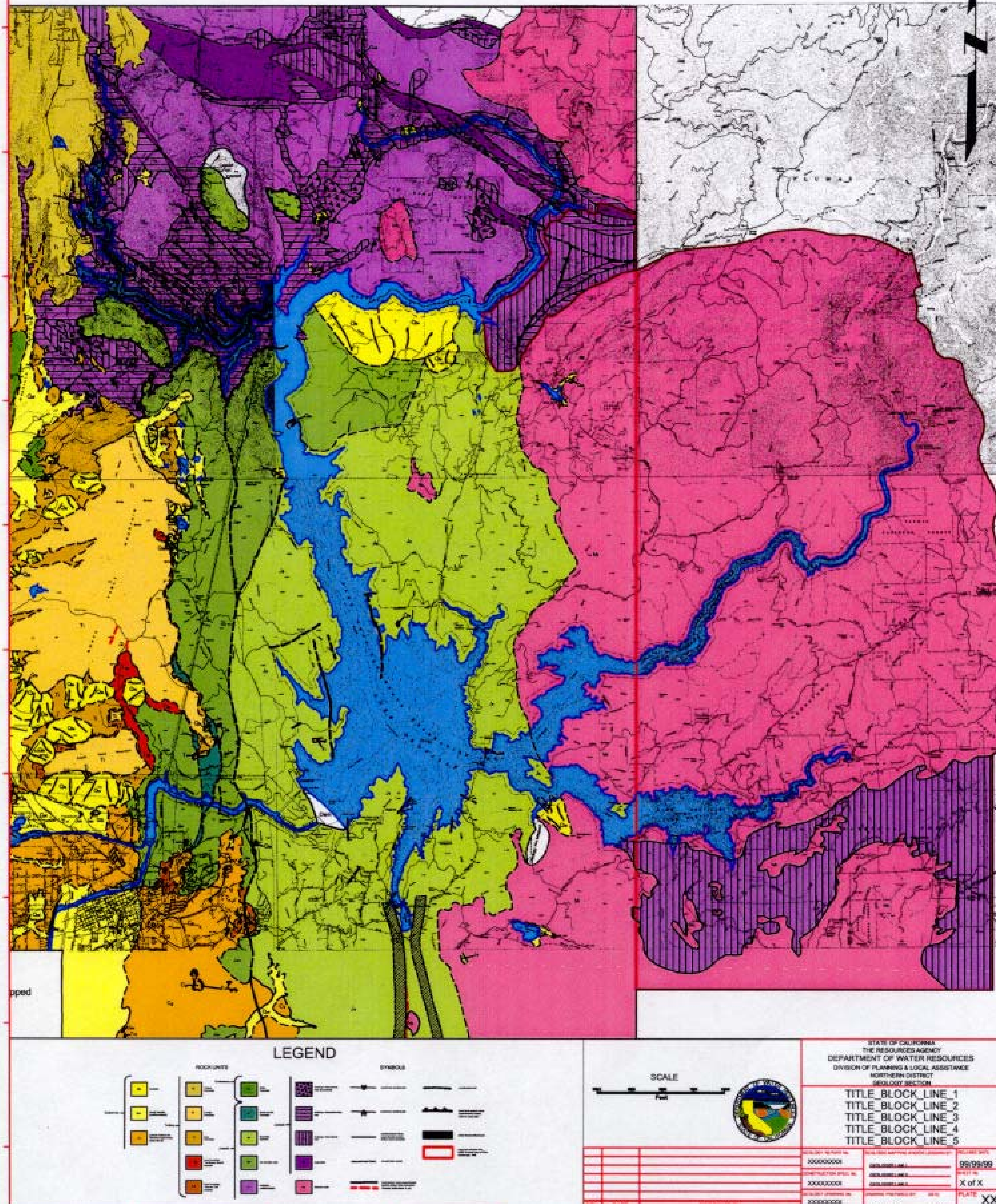

pped
LEGEND
ROCK UNITS
SYMBOLS
SCALE
Feet
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF PLANNING & LOCAL ASSISTANCE
NORTHERN DISTRICT
GEOLOGY SECTION
TITLE_BLOCK_LINE_1
TITLE_BLOCK_LINE_2
TITLE_BLOCK_LINE_3
TITLE_BLOCK_LINE_4
TITLE_BLOCK_LINE_5
XXXXXXXXX
XXXXXXXXX
XXXXXXXXX
99/99/99
X of X
PLATE
XX
REV
DATE
DESCRIPTION

Figure 4.2-2. Middle Fork sediment wedge entering lake.

Figure 4.2-3. North Fork sediment wedge entering lake.

Figure 4.2-4. West Branch sediment wedge entering lake.

Figure 4.2-5. South Fork sediment wedge entering lake.

Figure 4.2-6. Trapped sediments behind Miocene Dam.

Figure 4.2-7. Miocene Dam.

Figure 4.2-8. Pool merging into step run (Reaches 1 & 2) downstream from Jordan Hill Road crossing on West Branch.

Figure 4.2-9. Reaches 61 & 62 downstream from Miocene Dam.

Figure 4.2-10. Upstream end of sediment wedge on West Branch ending at Cape Horn.

Figure 4.2-11. Sediment wedge looking downstream; fine silt covers higher spot not reworked by river channel.

Figure 4.2-12. Reach 75 looking downstream on West Branch.

Figure 4.2-13. Reach 75 looking upstream on West Branch.

Figure 4.2-14. Flow over Big Bend Dam at around 10 a.m., August 22, 2002.

Figure 4.2-15. Flow over Big Bend Dam at around 2:00 p.m., August 22, 2002.

Figure 4.2-16. Full channel flow along Reaches 224 & 223 on North Fork.

Figure 4.2-17. Full channel flow along Reach 220 on North Fork.

Figure 4.2-18. Downstream end of sediment wedge on North Fork

Figure 4.2-19. Sediment wedge at Berry Creek on North Fork

Figure 4.2-20. Reaches 217 & 216 on North Fork.

Figure 4.2-21. Reaches 215 & 214 on North Fork.

Figure 4.2-22. Big Bend Dam with retained sediment.

Figure 4.2-23. Coarse grained sediment behind Big Bend Dam.

Figure 4.2-24. Middle Fork sediment wedge entering lake showing constant grade adjustment with lake level.

Figure 4.2-25. Middle Fork sediment wedge.

Figure 4.2-26. Middle Fork sediment wedge showing side bank of non-eroded sedimentary material.

Figure 4.2-27. Middle Fork sediment wedge material profile.

Figure 4.2-28. Upstream end of Middle Fork sediment wedge.

Figure 4.2-29. Upstream extent of field mesohabitat typing (Reach 148) on the Middle Fork.

Figure 4.2-30. Remnant sediment wedge along Middle Fork looking downstream.

Figure 4.2-31. Remnant sediment wedge along Middle Fork looking upstream.

Figure 4.2-32. Ponderosa Dam on South Fork spilling about 50 cfs; looking upsteam from below Reach 93.

Figure 4.2-33. Reach 93 looking downstream. Note water stain about two feet high.

Figure 4.2-34. Typical pool on South Fork (Reach 103).

Figure 4.2-35. Reach 107 downstream of Sucker Run Creek confluence.

Figure 4.2-36. Bedrock controlled pool (Reach 120) ending in a bedrock cascade.

Figure 4.2-37. Degraded habitat due to erosion of remnant sediment wedge.

5.0 STUDY RESULTS

This section is not addressed yet. Copies of slides from a Powerpoint presentation presented at the DWR Geo-conference in November, 2002 on the sedimentation study are included in this section. As time permits, the presentation will be presented at the Environmental Work Group meeting.

6.0 ANALYSES

This section is not addressed yet.

6.1 EXISTING CONDITIONS/ENVIRONMENTAL SETTING

6.2 PROJECT RELATED EFFECTS

7.0 REFERENCES

APPENDICES